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The Benefits of Regulating Hazardous Waste Disposal: Land Values as an Estimator

Executive Summary

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Summary of two phase conceptual and empirical examination of whether the social costs imposed by hazardous waste sites are reflected in residential property values. A hedonic analysis is used to account for other housing characteristics that affect property values. In Phase I, two sites were studied in detail, with some evidence of a rent gradient for one site (Pleasant Plains) but not for the other. In Phase I, more data were collected and analyzed for the Pleasant Plains site, which caused the apparent rent gradient to disappear. An unsuccessful attempt was made to locate a third hazardous waste site with air pollution and adequate property values data. The study fails to show that this property values approach is useful for estimating the damages from (or the benefits from more stringent regulation of) hazardous waste disposal.

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EXECUTIVE SUMMARY[1]

A. Introduction

Under contract with the U.S. Environmental Protection Agency, the Public Interest Economics Foundation (PIE) undertook to determine, on a sound theoretical basis with empirical verification, whether changes or differences in real property values constitute a valid and useful measure of the social costs imposed by a hazardous waste site and, hence, of the welfare gains potentially achievable through regulating the location or characteristics of such sites.

The use of land value techinques for estimating the benefits of regulating hazardous waste sites, if it could be established as theoretically sound and operationally practical, would prove most valuable in performing regulatory impact analyses and other evaluations of past or proposed regulation of hazardous waste sites. There are several reasons for this:

- o estimating the benefits of any environmental regulation is difficult, frequently even more difficult than estimating regulatory costs;
- o some widely used methods of estimating benefits are highly subjective;
- o in well-functioning real estate markets, the prices of surrounding real estate should both reflect most, if not all, of the value of the associated disamenities and provide entirely objective evidence

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[1]Because it is intended to stand alone, much of this Summary repeats verbatim material in the Preface to and the Conclusions of The Benefits of Regulating Hazardous Waste Disposal: Land Values as an Estimator: Volume II.

of that value. The principal hypothesis in this, as in any, study of the effect of hazardous waste sites on land values, is that the existence of the site depresses nearby land values and that the effect declines as the severity of the disamenity decreases, for example, with distance.

There is good reason to expect, a priori, that the hypothesis is valid. Both existing hazardous waste dumps and all other parcels of real estate are geographically fixed. Consequently, if the dump is in fact a disamenity, its presence should decrease the psychic income that could be generated by neighboring real estate; that reduction should be capitalized into the value of the property. The smaller the impact of the disamenity, the less property values would be affected by proximity to the dump. In general, then, we would expect the value of property further away to be depressed less than adjacent property. The theoretical bases of the hypothesis have been reinforced by successful application of property value analysis to evaluating other kinds of locational amenities or disamenities, as well as by the "common knowledge" that location is a, if not the, dominant factor in the determination of the value of real property.

The study was carried on in two phases, the first of which was reported in Volume I. This summary covers both phases but emphasizes the second. Phase II was built on Phase I and basically constitutes an expansion of the sample used in the analysis and an effort to rectify some of the deficiencies in Phase I.

The Phase II results diverge from and conflict with those of Phase I. The conclusions of Phase II are judged by the authors to be more reliable than the earlier ones, and those findings supercede the findings of the first phase.

B. The Major Conclusion

The major empirical finding of the entire study is that the hypothesis was not verified.

The preponderance of evidence failed to show any relationship between the hazardous waste site and the prices of nearby residences. No measurable general disamenity effects associated with proximity to the hazardous waste site were found. However, there was some very weak evidence that the prices of residences using well water that was found to be contaminated were depressed relative to other properties using well water.

In light of the plausibility of the hypothesis, the failure of the empirical effort to validate it raises serious questions. There are a limited number of possible explanations of the result. The first set pertains to the PIE-F study itself and the other to the general methodology. We discuss the more general, methodological explanation then, after a brief review of the study itself, the possiblity that the research was fatally flawed.

The conclusion that the method is not generally valid or useful for predicting the potential benefits of regulating hazardous waste sites is quite contrary to the expectations of the PIE staff. It appears to derive from the prevalence of several, somewhat overlapping, sets of factors that tend to obstruct the use of the technique rather generally and that became apparent only in the course of PIE's research.

The method imposes some requirements on empirical analysis that are difficult to fulfill in any individual case and that, therefore, are likely to be impossible to fulfill in a large enough number of cases to permit general application of the method for use in regulatory analyses.

The method involves predicting the prices of parcels of real estate as a function of some measure of disamenity. Clearly, there are a large number of factors that affect the value of a piece of real property, some of them likely to exert far stronger influence than the proximity of a single disamenity; such characteristics as size, number of rooms, age, are examples. To reflect the factors in addition to the distance from identified contamination, it proved necessary to include a total of 43 raw variables, from which over 150 parameter values were developed. It is possible that important factors were still left out. Thus, a large number of observations, i.e., real estate transactions, close enough to the site to have the potential of being perceptibly affected is required. This, in turn, dictates that the site be in an urban residential area. In contrast, the parcels involved in commercial, farm or undeveloped residential land tend to be too large to permit enough transactions for an adequate sample within a suitably constrained area and interval of time. As discussed subsequently, the use of such a site, itself, introduces some factors that can be expected to obscure any actual impact of the hazardous waste site on property values in the affected market.

In order that the health risks and other disadvantages of living close to a hazardous waste site might affect psychic income and, hence, property values,. the nature of the disadvantages must be appreciated by participants in the housing market. Should some of the effects--such as health impacts--be partly externalized or should the existence of hazardous substances in a site not be widely known, housing prices could not reflect the full negative value of exposure to the risks. Therefore, it is necessary that the consequences of proximity to a site be understood by the

public. Further, for a before-and-after analysis of housing prices to be meaningful, there must be an identifiable period in which the population first became aware of the risks.

The importance of awareness affects the appropriate method of analysis. Future efforts to employ land value analysis might well be accompanied by surveying the population to determine the extent and timing of awareness. While it is possible to observe parts of the process by which market participants learn of a disamenity, particularly the type of information disseminated, little is known about residents' perceptions. The lack of information about the perceptions of buyers and sellers as to the characteristics of a hazardous waste site, means that proxy variables must be used. These can be based only on somewhat subjective judgements about potential reactions to the disamenity.

In order for the (expected) gradient in property values to be attributed to a hazardous waste site, it is necessary that the site not be collocated with any other important disamenity or amenity. The consequence of collocation is that it is impossible to isloate the effect of one amenity or disamenity. Residential areas are characterized by the presence of amenities, such as schools and recreational facilities, and many moderately dense urban areas contain diseminities such as nodes of traffic congestion or industrial plants.

The fact that governments react also complicates the analysis. Ideally, for purposes of analysis, a hazardous waste site should be left alone while the real estate market has an opportunity to reach a new equilibrium, reflecting the value of the disamenities created by the site. However, with reasonably responsive local governments, it is far more

likely that the adverse impacts of any site will be eliminated or offset, in whole or in part. To the extent that such action is taken at public expense and to the extent that it is both effective and perceived to be effective, there is no subsequent loss of value of real property in the area. In such circumstances, observations of real estate prices would not reflect the economic value of regulating the site. Even if the ameliorative action were taken at private expense, if it required a one-time expenditure rather than continuing outlays, amelioration, once accomplished, would have created only a sunk cost which could have no subsequent influence on values. Should there be doubt as to the efficacy of ameliorative action, the risk of future disamenities would, of course, tend to somewhat depress prices of proximate property.

In general, if the consequences of a hazardous waste dump were serious enough to cause a substantial impact on property values, they would, for that reason, tend to cause ameliorative action to be taken. Thus, the more likely it is that market forces would produce a discernible negative impact on real estate prices, the more likely political forces will eliminate or reduce that impact.

In addition to the problems just discussed, there are two theoretical factors that undermine the usefulness of the technique. First, a hazardous waste site is a land-intensive activity. Consequently, ordinary prudence in minimizing the cost of an economic activity would lead to the location of (either legal or illegal) dumps in areas where land values are low. Thus, there is an identification problem built into the analysis by the nature of the phenomenon being analyzed. Second, a hazardous waste site may not constitute a disamenity to all land users. For example, the costs

of carrying on some industrial activities may be reduced by proximity to a site for disposal of the hazardous wastes they generate. Any such cost saving would tend to be reflected in land rents.

Finally, it is necessary that the real estate market from which observations are drawn be homogeneous. One of the problems with the Pleasant Plains site is that the "quality" of Pleasant Plains improved, relative to other areas in the local real estate market, during the period under analysis. In a sense, this can be considered to be a form of collocation, but one that varies over time.

One of the consequences of these constraints that are imposed by the method itself is, as has already been mentioned, that the number of sites suitable for analysis is very small. Collocation with hazardous waste sites of other disamenities or of amenities was found to be common in urban areas. Further, ameliorative action often was found to have taken place soon after any problem was discovered. Our search[2] for sites suggests that it is difficult to find hazardous waste sites suitable for making empirical tests of the property value technique.

C. The Study

To test the hypothesis, namely, that the existence of a site depresses local land values, with reduced impact as the severity of the disamenity lessens, PIE undertook a two-phase study. We developed a relevant theoretical structure and applied it in two case studies.

In Phase I (reported in Volume I) the potential application of hedonic demand theory was analyzed and existing applications of the technique were

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[2]See Appendices A and B, Volume II.

reviewed. Many sites were examined to ascertain whether they were suitable for analysis. In Phase I, two sites were analyzed; in Phase II (Volume II), one of those was examined somewhat more intensely.

Of two plausible approaches,

- a broad cross-sectional analysis, in which data are aggregated from many sites and
- an analysis of sites individually,

the latter was chosen, primarily on grounds of feasibility.

The choice of sites was limited because of the requirement of a large number of observations, as already noted. For the sites selected, it was decided to use transaction price rather than assessed value as the variable to be explained. Although using assessed value would have increased the number of observations available, it is market value that is relevant. Unfortunately, assessed values are often difficult to transform into market values.

The principal hypothesis of any study using property values to measure the impacts of a hazardous waste site or sites must be, as mentioned above, that such a disamenity[3] depresses property values in its vicinity. In this study, disamenity effects were defined as any welfare losses experienced, including health costs and negative aesthetic values, and the expectation of incurring such losses. However, it is impossible to measure directly the disamenities associated with such a site; therefore it was necessary to develop proxies for them in Phase I. Distance from

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[3]A finding that property values were enhanced by proximity to a hazardous waste site would be consistent with a hypothesis that such a facility is an amenity.

the site was the primary surrogate used; a secondary one was the published identification of areas where groundwater was found to be contaminated.

To test the effect of a hazardous waste site, as reflected in either of the proxies, two techniques were used in both phases of of the study. The first consists of developing a single cross-sectional equation showing, as a function of the appropriate proxy, property values within the potentially affected area. The expected result is a gradient of land values depressed by the known contamination and rising as a function of distance or of the absence of contamination. With this technique, the transactions observed must have occurred after a site was established, or after some incident that makes obvious to the participants in the local real estate market the consequences of the site's existence; an explosion or the detection of contamination is such an incident.

The second technique consists of creating and comparing two such equations, one incorporating prices before and one incorporating prices after the creation of the site or the conspicuous event. The latter technique, a combined cross-sectional/time-series analysis, appears superior, where data from both periods are available.

In Phase I, after a fairly exhaustive survey of the Superfund list for suitable sites, two were chosen--one in Pleasant Plains, New Jersey; one in Andover, Minnesota[4]. An empirical analysis of each site was conducted and a specific model, reflecting its characteristics and those of its environs and proximate population, was developed.

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[4]Pleasant Plains is a subdivision of the town of Toms River; Andover is a suburb of Minneapolis.

For Andover, a single cross-sectional equation was derived in Phase I to test a sample of post-contamination transactions using distance as the proxy for the intensity of the disamenity.

In the Pleasant Plains area, two samples were used in both phases: a "before" sample of transactions which occurred prior to 1974 and an "after" sample of those which occured susequent to 1974. Although dumping took place in 1972, public concern was not expressed until contamination of private wells in the vicinity was discovered in 1974, at which time an official contamination zone was established (incidentally providing an alternative to distance as a proxy for this site).

Using these two samples, the potential benefits of regulating the Pleasant Plains site were estimated by examining the effect of the contamination incident on property values and by using pre-existing data on costs incurred because of the existence of the site, such as estimates of clean-up costs.

The Pleasant Plains data revealed a weak and inconclusive, positive relationship between distance and property values. The Andover sample revealed no measurable relationship between those variables.

The major findings of Phase I with respect to Pleasant Plains are as follows:

- o If there were any effect of proximity to the site, it was weak.
- o Consequently, it was difficult to separate the negative price impact of the presence of the hazardous waste site from the positive price impact attributable to the increasing popularity of the area in which the dump is located.

- o The alternative independent variable, identified contamination zones, was flawed because the official contamination zones were not reliable and consistent indicators of actual contamination.
- o Because of these facts it was difficult to evaluate either distance or contamination as proxies for the effect of the hazardous waste site.

Upon completion of Phase I, it was decided that the empirical results were inconclusive with respect to the following:

- o the validity and usefulness of the technique,
- o the value of the disamenity and, even,
- o whether the hazardous waste sites did, in fact, constitute a disamenity, at least in these specific cases.

Because of the inconclusiveness of Phase I, it was decided to pursue the problem further in the context of the Pleasant Plains site, in an effort to eliminate those problems. It was also concluded that no further analysis of the Andover site was justified and that extension of the study to at least one additional site would increase EPA's ability to evaluate the approach. Phase II was undertaken as a consequence of these decisions.[5]

Empirical work on the Pleasant Plains sample in Phase II was directed towards rectifying the shortcomings of the first phase. The following steps were taken:

1. The size of both the pre-1974 and the post-1974 samples in Pleasant Plains was increased, with emphasis on localities not sampled or not adequately sampled in Phase I;

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[5]As mentioned previously, Phase II is reported in Volume II; Appendices A and B o that volume describe the search for sites to analyze, Appendix C provides summaries of all the runs in Phase II, while Appendix D addresses comments by reviewers of the first phase.

2. More information was collected on both the extent of contamination and the impacts on individual households of the local ordinances pertaining to ground water contamination.
3. A test was made to determine, in a general fashion, whether values were depressed more in one direction from the site than in others.

Phase II also included a search for a third hazardous waste site to analyze. Four new models were developed for Phase II to analyze the enlarged and improved data set. In addition to the principal hypothesis, secondary hypotheses concerning the nature and pattern of the response of real estate markets to the hazardous waste site were specified and examined. In particular, the response of prices of residential properties with well water that had been found to be contaminated were examined in greater detail. In addition, more emphasis was placed on the possible impact of the direction of underground flow.

D. Empirical Findings

The methodological conclusions of the entire study have already been discussed. Here we mention the empirical findings specific to the two sites examined.

The analysis, in Phase I, of Andover, Minnesota, stands as the most advanced study of that site that is feasible with any reasonable expenditure of resources. It produced no evidence of any impact of the hazardous waste site on real property values.

In the case of Pleasant Plains, the analysis performed in Phase II supercedes that performed in the first phase. The second phase incorporated both a more complete sample and additional techniques designed to answer questions raised by the first attempt.

The preponderance of evidence failed to show any relationship between the hazardous waste site and the prices of nearby residences.

E. The Validity of the PIE Approach

As was pointed out above, the failure of the study reported here to find a gradient of real estate prices as a function of the severity of the disamenities associated with hazardous waste sites--if in fact one exists--could derive from either problems inherent in the method or deficiencies in its specific applications by PIE. The former has been discussed above, and it was concluded that there are important difficulties inherent in the method. It remains to discuss possible shortcomings of the PIE application of the land-values method.

The PIE study could have been deficient in either of two respects: the Pleasant Plains site could have had peculiar characteristics that made it an inappropriate laboratory for testing the method, or the PIE analysis might have been internally faulty.

Addressing the latter first, while it has been possible to examine only a limited number of econometric techniques in this study, the probability that any other techniques would yield results different from those obtained in this analysis is low. This view is supported primarily by the facts that the regression results were reasonably consistent throughout the analysis and that they predicted property values with adequate confidence and typically with the expected signs. Outside reviewers have supported this view; several of them suggested further refinements of the analysis, but none suggested that these refinements would alter the basic results.

This leaves the possibility that the Pleasant Plains (and Andover) site was inappropriate and that the selection of alternative sites would have provided a more propitious test of the technique. In fact, the efforts of the study team to find even as good a site proved virtually fruitless. Nevertheless, there are some infirmities associated with the Pleasant Plains site and some specific aspects of the analysis warrant comment.

Data deficiencies, ameliorative action by the government and the collocation of the hazardous waste site with other sources of disamenities or amenities, all presented problems.

Inadequacy of data was primarily responsible for the difficulties associated with specifying the variable serving as a proxy for the effects of the hazardous waste site. The (small) size of the sample of observations close to the site made it difficult to test distance adequately as a proxy. Further, the lack of reliable evidence of contamination meant that it was not possible to create a completely satisfactory contamination proxy.

Another problem with the use of the Pleasant Plains site arises because discovery of contamination occurred during a period in which the values of properties relatively close to the dump were appreciating in response to increased popularity of the area, attributable apparently, at least in part, to the development of a retirement community in Pleasant Plains.

Another factor which complicated the testing of the proxy variables was the ameliorating action undertaken to reduce current adverse consequences and future risks associated with the site. The government's

action occurred almost immediately after contamination was discovered. To the extent that such action is atypical, the specific study is similarly atypical. However, there is little reason to suppose that governments will not respond to important instances of contamination.

F. The Benefits of Regulating Hazardous Waste Sites

It is essential to make clear that the failure to identify any effect of proximity to a hazardous waste site on property values does not suggest that the economic cost of hazardous waste sites is small or that, similarly, the benefits of regulating them are not potentially large.

First, the inability to exclude the effects of collocation of other activities that "seek" low cost locations and that generate disamenities means that the effects of a hazardous waste site in isolation tend to be underestimated. Presumably each collocated disamenity makes a contribution to downward pressures on prices in the nearby area and, therefore, removal of any one of them would tend to increase the marginal value of removing each of the others. However, lack of variation in the presence of disamenities precludes estimating the marginal effect of each when the study is of a single hazardous waste site.

Second, the fact that the Pleasant Plains area became more desirable after the "incident" means that any adverse effect of the dump on property values was obscured. Prices in the area would, presumably, have risen more than the increase actually observed had the hazardous waste site been absent.

Third, the fact that ameliorative action was taken promptly eliminated much of the basis for any reduction in housing prices. The impact of ameliorative action suggests that the economic value of regulating a

hazardous waste site may be bounded from above by the costs of amelioration if such action is entirely effective and is perceived as being so and if all costs would otherwise be embodied in the depression of property values. The latter is almost certainly not true in many cases, because of lack of awareness.

In this connection, it is important to note that the costs of amelioration in Pleasant Plains was apparently relatively low, because a municipal system not dependent on contaminated ground water was a readily available substitute for private wells. Where such an alternative does not exist, costs of amelioration would be relatively high. Further, if contamination is wide spread, alternative sources of water are likely to be relatively costly, and, should municipal sources be contaminated, the costs of isolating or replacing the contaminated ground water might be high indeed.

If there is insufficient information as to the nature of the dump and the associated risks, even an ideal analysis of land values would fail to capture all the costs of the dump and therefore all of the value of regulating it.

Finally, there may be some costs that cannot be identified in any land value study, namely costs that are never appreciated or that are excessively discounted in the real estate market. The most obvious example is the cost of health risks that are not perceived during the period when the real estate market is under observation.

Consequently, the finding of no gradient in real estate prices does not constitute evidence that regulating hazardous waste sites is not of economic value.